



# THE PARADOX OF LEARNING: APPLYING THE SCIENCE OF READING PAPER-BASED TEXTBOOKS IN TODAY'S DIGITAL WORLD

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## ABSTRACT

The widespread adoption of digital media as a replacement of printed media has led to a trend in the education industry where digital textbooks have become increasingly popular. However, despite the rising fame of digital media, there are still concerns regarding the efficiency of using digital textbooks as a source of learning. This paper investigates the concept of reading digital textbooks and analyzes whether doing so is indeed preferable than reading paper-based textbooks. In-depth secondary research was conducted and findings from various studies were assimilated, which are individually explained from psychological and neurological perspectives. As a result, reading from traditional paper/print textbooks was revealed to be more efficient than digital textbooks in terms of reading comprehension and recall of information. Hence, the views of both textbook versions were evaluated, ultimately arriving at the conclusion of emphasizing the importance of choice and the ability to adapt quickly in new environments, in this case, the digital world.

**KEYWORDS:** eBooks, Digital Media, Learning, Cognitive Benefit, Spatial Memory Networks.

## INTRODUCTION

Since the very start of the Information Age, in mid-20th century, large technological breakthroughs such as the invention of the telephone by Alexander Graham Bell in 1876 or the first ever sound broadcast through the AM radio stations in the early 1900s have been revolutionizing communications and the spread of information (Lallana, 2003, p.5).<sup>1</sup> Presently, a century after those inventions, studies believe that technology has reached its tipping point (World Economic Forum, 2015), leading a crucial role in our daily lives.<sup>2</sup> A major example of it would be the enormous migration from the use of paper-based textbooks to digital textbooks in the education industry. However, despite the popularity of eBooks and tablets, several studies suggest that reading on paper is certainly much superior to its alternative by a variety of factors.

*Source: Primary data*

*CAHSS = College of Arts, Humanities and Social Sciences*

*CEHHS = College of Education, Health and Human Sciences*

*COM = College of Management*

*CSTEM = College of Science, Technology, Engineering and Mathematics*

**Figure 1: Past and future use of e-textbook across demographics**  
(Kavita Chavali, February 2022, p.244)

## BACKGROUND

### *The eBook Dilemma*

Digital books otherwise referred to as eBooks are devices that offer the ability to rent digital versions of traditional textbooks, moreover they are accessible through any online device. In some cases, digital textbooks can be accessed for free, if they are part of the public domain in cyberspace (Public School Review, January 2023).<sup>3</sup> As digital textbooks are relatively affordable, more convenient to carry and customizable to individual learning styles and needs, with features such as adjustable text size, highlighting, brightness, their use in the education industry was always prevalent, with reports from decades ago confirming that the sales of digital textbooks were gone up to 400 percent between 2008 and 2009 (American Association of State Colleges and Universities, winter 2013).<sup>4</sup> However, as a result of COVID-19, an infectious disease caused by the SARS-CoV-2 virus<sup>5</sup> (World Health Organization, 2020), remote working and “hybrid” learning was required for over 2 consecutive years, thus accelerating the adoption of digital textbooks even more. If in 2020, just after the pandemic lockdowns were implemented, OverDrive Education, the leading digital reading platform for schools worldwide, reported a record number of 38000 K12 schools in 71 countries allowing students to read e-textbooks<sup>6</sup> (OverDrive, December 2020). Today, OverDrive is offering digital content to more than 88000 schools in 109 countries (OverDrive, December 2022).<sup>7</sup>

The popularity of e-textbooks is applicable to higher education as well, with a study from Dhofar University stating that 98.55% of students studying at a mid-western university in the US confirmed to have used an e-textbook in the past, with more than 60% of the sample preferring to continue using the digital version in the future (Kavita Chavali, February 2022, p.244)<sup>8</sup>. Several other studies claim that behind such high numbers of e-textbook user students lie the educators' beliefs. According to Nielsen Research Company, 49% of educators in US Higher Education believe that when e-textbooks are introduced in their courses, overall student comprehension and understanding of the course material is improved, 46% believe that the students are better engaged with the course, 20% believe that the use of e-textbooks is effective in accommodating different levels of students (Chavali, 2022, p.243)<sup>9</sup>. However, in the last few decades, various studies were conducted by experts in many different fields - including psychology, neurology, computer science, marketing - to put an end to the textbook dilemma, from which the findings contrasted with the general public opinion.

Demographic Variable		Past / Current use of e-textbook		Future use of e-textbook		Difference
		Yes	No	Yes	No	
Gender	Male	183	3	123	63	+60
	Female	158	2	99	61	+59
	Total	341	5	222	124	+119
Year in the University	Freshman	35	2	28	9	+7
	Sophomore	55	0	37	18	+18
	Junior	124	2	82	44	+42
	Senior	127	1	75	53	+52
	Total	341	5	222	124	+119
College Affiliation	CAHSS	50	2	36	16	+14
	CEHHS	96	1	58	39	+38
	COM	127	1	86	42	+41
	CSTEM	68	1	42	27	+26
	Total	341	5	222	124	+119
Current GPA (c-GPA)	Below 2.00	1	0	0	1	+1
	2.00-2.50	11	1	10	2	+1
	2.51-3.00	73	1	47	27	+26
	3.01-3.50	164	1	105	60	+59
	3.51-4.0	92	2	60	34	+32
	Total	341	5	222	124	+119

### The Science behind Reading Print Textbooks

The human brain is an incredibly complex and adaptable organ, and reading has the potential to help individuals develop new neural pathways and improve cognitive abilities. One of the main advantages of reading is that it helps to stimulate brain activity and improve cognitive function. This is because reading requires the use of multiple parts of the brain, including the visual cortex for processing the words on the page, the language centers for processing and comprehending the words, and the executive centers for decision-making and problem-solving. By engaging all of these areas, reading can help to improve overall brain function and result in improved ability to think critically and solve problems. Another cognitive benefit of reading is that it helps to improve memory and increase the brain's ability to retain information. When we read, we store information in our long-term memory, which helps to strengthen our memory recall and improve our ability to recall important details in the future. In regards to emotional development, reading has the potential to increase empathy and understanding by exposing the reader to diverse perspectives, cultures, and experiences. This can lead to improved relationships and a greater sense of community. To review, reading is a highly beneficial activity that offers numerous advantages to individuals, from improved cognitive function to greater social and cultural awareness.



NB The red area in the images of the brain represents greater oxygenated blood flow (and hence activation) stimulated by physical ads. The blue areas are regions activated more by virtual ads. The "cross hairs" highlight the named brain region.

**Figure 2: fMRI scan of right and left parietal lobes**  
(Millward Brown, 2009)

To determine if these processes are influenced by the reading medium, a study was conducted by Bangor University and market research firm Millward Brown. A sample of 20 participants were shown ads, which were either printed on cards or displayed on-screen. While participants interacted with the materials, an fMRI machine was used to assess how the brain was reacting to physical and virtual stimuli. The findings concluded that "tangible materials leave a deeper footprint in the brain". For instance, the material shown on cards generated more activity within the area of the brain associated with the integration of visual and spatial information (refer to Figure 2), which suggests that paper-based media is more "real" to the brain. It has a higher meaning and a place. It is better connected to memory because it engages with its spatial memory networks. Additionally, physical material involves more emotional processing, which is important for memory and brand associations (Brown, 2009).<sup>10</sup>

The study by Millward Brown compared the effect of print and digital advertising. Similarly, another study conducted in a school context came up with the same conclusions; stating that reading physical material is more effective than digital material in terms of comprehension. The sample consisted of 72 10th graders from two different primary schools in Norway. Although the sample might lack population generalisability, meaning the results might not be applicable to international students with different education systems, in terms of age, the results could definitely represent the general population of high school students. The participants were divided into two groups by random allocation (to decrease the chances of participant variable impacting the results), where the first group read two texts (1400 – 2000 words) in print, and the other group read the same texts as PDF on a computer screen (printCAN, April 2020)<sup>11</sup>. Afterwards, a reading comprehension test was taken from both groups. Using the scores, a multiple regression analysis was carried out to investigate to what extent reading modality would influence the students' performance on the reading comprehension measure. Thus, producing results that indicated students who read texts in print scored significantly better on the reading comprehension test than students who read the texts digitally (Mangen et al. 2013)<sup>12</sup>.

### DISCUSSION

After thoroughly investigating and analyzing a number of studies from psychological, neurological, marketing and educational perspectives, the combined findings all suggest that reading from traditional print textbooks is much more advantageous than digital textbooks in terms of reading comprehension and recall of information. When reading on paper, people tend to be more engaged and focused, and they are often better able to absorb information and retain it for longer periods of time.

On the contrary, reading on a screen has its own set of benefits. It is portable, allowing readers to carry hundreds of books with them on a single device. Screen reading is also often more accessible for people with visual impairments, as it offers adjustable text size, brightness, contrast and even a speech synthesizer.

However, for more immersive and in-depth reading, paper textbooks are the preferred choice. We can apply these findings in the education industry in more than one way. For instance, in classes that do not involve immersive reading, but focus more on problem-solving, computation, conceptual understanding, such as mathematics, physics, using digital textbooks can be encouraged, whilst in classes, that focus more on in depth reading and comprehension, research and information literacy, writing and analyzing, traditional textbooks might be suitable. In examinations as well, as studies have shown, providing printed materials will lead to higher chances of improved student performance. Standardized tests such as the SATs, which a great deal of students take annually, could be considered to be converted back to its printed version, instead of digital, as the test does require students to read a large amount of information in a limited time with full comprehension.

### CONCLUSION

The textbook debate, as paradoxical as it is, can conclude both the digital and paper-based versions as "champions". While reading on paper may be more effective for retaining information and offer a more engaging experience, reading on a screen offers greater convenience and accessibility. The choice between them ultimately comes down to individual preferences and reading goals.

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